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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the power unit of the turbo molecular pump used in order to form a vacua in the equipment relevant to semiconductor fabrication machines and equipment, thin-film-fabrication equipment, liquid crystal, or liquid crystal equipment.

[0002]

[Description of the Prior Art] Generally, the turbo molecular pump is equipped with various models, and voltage, current, etc. which are impressed to the rotational frequency of a motor and motor of the main part of a turbo molecular pump according to a model differ from each other. Therefore, in order to drive the motor of the main part of a turbo molecular pump of each model, the power unit of the exclusive use for performing the electric power supply and control corresponding to each property and conditions is needed.

[0003] Moreover, in the case of the turbo molecular pump of a magnetic-levitation formula, since the mass and the center-of-gravity position of the Rota wings differ from each other for every model, the magnetic-levitation control circuit of the exclusive use corresponding to each control characteristic is needed at the power unit side. Drawing 5 is an outline block diagram for explaining the composition of the conventional turbo molecular pump. A turbo molecular pump is equipped with the main part 1 of a turbo molecular pump, and a power unit 2 in drawing 5. The main part 1 of a turbo molecular pump is equipped with the temperature detection mechanism 5 for having the revolving-speed-control system 4 containing the rotation sensor 13 which detects the rotational frequency of the motor 14 which drives the Rota wings, and a motor, having the magnetic bearing control system 3 containing the displacement sensor 11 which detects the electromagnet 12 and the Rota position for a magnetic bearing, in carrying out magnetic levitation of Rota, and detecting the temperature of a motor or a gas path.

[0004] A power unit 2 is equipped with the motor control section 7 which controls the revolving-speed-control system 4, and the magnetic bearing control section 6 which performs control of the magnetic bearing control system 3, and the set points, such as a control parameter of magnetic bearing control to which the optimal magnetic-levitation control is made to perform according to the control parameter of revolving speed control which carries out optimal operation of the motor according to the model of turbo molecular pump, the mass of the Rota wings, a center-of-gravity position, etc., are set up. Moreover, based on the detecting signal from the temperature detection mechanism 5, it has the temperature-control section 8 which performs the malfunction detection of motor temperature, and the temperature control of a heater.

[0005]

[Problem(s) to be Solved by the Invention] In the conventional turbo molecular pump, since the combination of the main part of a turbo molecular pump and a power unit is defined for every model, as for the number of kinds of the power unit which should be prepared beforehand, only the number of kinds of a turbo molecular pump is needed, and a power unit has the trouble of needing many kinds. The need for the power unit of this variety becomes the factor which futility produces in stock of a power unit, or management of supply.

[0006] Moreover, in changing a design for the motor and the Rota wings of the main part of a turbo molecular pump and forming a new model, there is a trouble that the power unit which set up the control parameter of the revolving speed control of a motor and the control parameter of a magnetic bearing to compensate for the design change is newly needed. Usually, since it corresponds to failure of a turbo molecular pump, the number of kinds of the power unit which needs to hold stock of the main part of a turbo molecular pump and a power unit, and needs to hold also about the power unit of the old model with model change of the main part of a turbo molecular pump, and it continues holding will also increase.

[0007] Then, this invention solves the trouble which said conventional turbo molecular pump has, and it aims at decreasing the number of kinds of a power unit to two or more kinds of main parts of a turbo molecular pump.

[0008]

[Means for Solving the Problem] the control parameter of the model distinction circuit which this invention detects the electrical property peculiar to a model which the electric composition section of a turbo molecular pump equips with the body of revolution which has \*\*\*\* for exhaust air, and a motor in the power unit of the turbo molecular pump which carries out magnetic-levitation support by the magnetic bearing, and distinguishes the model of turbo molecular pump from this electrical property, and the control circuit which control the motor of a turbo molecular pump -- and -- or it has the control-parameter setting circuit which sets up the control parameter of the control circuit which controls a magnetic bearing based on the output

of a model

[0009] The electric composition section of a turbo molecular pump is a component which performs electric operation containing the motor which carries out the rotation drive of the body of revolution, the magnetic bearing to which magnetic levitation of the body of revolution is carried out, or the temperature sensor installed in the main part of a turbo molecular pump, and electrical properties, such as electric resistance and an inductance, differ according to the model of turbo molecular pump. A model distinction circuit is a circuit which outputs the model distinction signal which detects an electrical property peculiar to the model of this turbo molecular pump, and distinguishes the model of turbo molecular pump.

[0010] According to the power unit of the turbo molecular pump of this invention, if a power unit is connected to the main part of a turbo molecular pump, the model distinction circuit in a power unit will detect electrical properties, such as resistance of the electric composition sections, such as a motor in a turbo molecular pump, a magnetic bearing, or a temperature sensor, and an inductance. By using a different electrical property according to the model of turbo molecular pump of this electric composition section, a model distinction circuit distinguishes the model of turbo molecular pump based on the detected electrical property, chooses the control parameter suitable for the model from the control parameters beforehand stored with this model distinction signal further, and sets up the control parameter of the magnetic bearing control section which controls the motor control section which performs revolving speed control of a motor, and a magnetic bearing.

[0011] The 1st embodiment of this invention performs model distinction of the main part of a turbo molecular pump by detecting the resistance range of a different temperature sensor for every model of main part of a turbo molecular pump using the temperature sensor which detects the abnormalities in temperature of a motor as the electric composition section which performs model distinction. Moreover, the 2nd embodiment of this invention performs model distinction of the main part of a turbo molecular pump by detecting the resistance range of a different temperature sensor for every model of main part of a turbo molecular pump using the temperature sensor for performing the temperature control of the circulation space of a turbo molecular pump as the electric composition section which performs model distinction.

[0012] The 3rd embodiment of this invention performs model distinction of the main part of a turbo molecular pump by detecting the different coil resistance or the different coil inductance of a motor for every model of main part of a turbo molecular pump, using a motor as the electric composition section which performs model distinction. Moreover, the 4th embodiment of this invention performs model distinction of the main part of a turbo molecular pump by detecting the different coil resistance or the different coil inductance of a magnetic bearing for every model of main part of a turbo molecular pump, using a magnetic bearing as the electric composition section which performs model distinction.

[0013] Since the control parameter according to the model of connected main part of a turbo molecular pump can be set up in the power unit of the same model according to the above-mentioned composition, the number of kinds of a power unit can be decreased to two or more kinds of main parts of a turbo molecular pump. Moreover, in the main part of a turbo molecular pump, since model distinction is performed by detecting the electrical property of the electric composition sections, such as a motor, a magnetic bearing, a temperature sensor, etc. with which the main part of a turbo molecular pump itself is equipped, the cable which makes a component, wiring for it, and connection between the model distinction circuits by the side of a power unit separately because of model distinction can be made unnecessary.

[0014]

[Embodiments of the Invention] Hereafter, the form of operation of this invention is explained in detail, referring to drawing. The example of composition of the form of operation of this invention is explained using the outline block diagram explaining the 1st operation form of the power unit of the turbo molecular pump of this invention of drawing 1. The 1st operation form detects the electrical property with which the abnormal-temperature detection sensor of a turbo molecular pump is equipped peculiar for every model, and distinguishes the model of main part of a turbo molecular pump.

[0015] In drawing 1, a turbo molecular pump is equipped with the main part 1 of a turbo molecular pump, and a power unit 2 like aforementioned drawing 5. the revolving-speed-control system 4 of the main part 1 of a turbo molecular pump The rotation sensor 13 which detects the rotational frequency of the motor 14 which drives the Rota wings, and a motor is included. the magnetic bearing control system 3 It has the abnormal-temperature detection sensor 15 for detecting the abnormalities in temperature of a motor as a temperature detection mechanism 5, including the displacement sensor 11 which detects the electromagnet 12 and the Rota position of the magnetic bearing to which magnetic levitation of Rota is carried out. The resistance element from which resistance changes according to the temperature of a fixed resistor, a resistance bulb, a thermistor, etc. can be used for the abnormal-temperature detection sensor 15.

[0016] The rotation sensor circuit 23 where a power unit 2 searches for a rotational frequency signal from the rotation sensor 13, The inverter circuit 24 which supplies power to a motor 14, and the 2nd control computing element 27 which controls an inverter circuit 24 based on a rotational frequency signal, By the revolving-speed-control constant setting circuit 28 which a setup of the control parameter of the 2nd control computing element 27 is performed, and makes a change The displacement-sensor circuit 21 which constitutes the motor control section 7 which controls the revolving-speed-control system 4, and searches for a displacement signal from a displacement sensor 11, By the power amplifier 22 which supplies power to an electromagnet 12, the 1st control computing element 25 which controls power amplifier 22 based on a displacement signal, and the magnetic bearing control-parameter setting circuit 26 which a setup of the control parameter of the 1st control computing element 25 is performed, and makes a change The magnetic bearing control section 6 which controls the magnetic bearing control system 3 is constituted.

[0017] The revolving-speed-control constant setting circuit 28 stores the control parameter of the revolving speed control of the motor according to the model of turbo molecular pump. It is the circuit which sets up by choosing the optimal control

parameter for the connected motor out of the control parameter. moreover, the magnetic bearing control-parameter setting circuit 26 It is the circuit which stores the control parameter of magnetic bearing control to which the magnetic-levitation control according to mass, a center-of-gravity position, etc. of the Rota wings of a turbo molecular pump is made to perform, and sets up by choosing the optimal control parameter for the motor connected out of the control parameter.

[0018] Furthermore, the power unit of this invention is equipped with the model distinction circuit 31. With the operation gestalt shown in drawing 1, model distinction of the main part 1 of a turbo molecular pump is performed based on the detecting signal obtained from the abnormal-temperature detection sensor 15 by the side of the main part 1 of a turbo molecular pump. The model distinction signal of the model distinction circuit 31 is sent to the revolving-speed-control constant setting circuit 28 and the magnetic bearing control-parameter setting circuit 26, and selection of the control parameter corresponding to the model is performed. Moreover, the temperature conversion circuit 32 and interlock 33 in drawing 1 are the composition for preventing the abnormalities in temperature of a motor, and perform malfunction detection and control based on the detecting signal from the abnormal-temperature detection sensor 15.

[0019] Next, setting operation of the control parameter by the operation form of drawing 1 is explained using drawing 2 (a). For every model, the resistance of the resistance element of the abnormal-temperature detection sensor 15 formed in the main part 1 of a turbo molecular pump is changed so that it may not lap, and it is set up. For example, in 20 degrees C - 150 degrees C of operating temperature limits of a turbo molecular pump, the resistor used as 20kohm-25kohm is used from Model B using the resistor used as 10kohm-15kohm by Model A.

[0020] When a power unit 2 is connected to the main part 1 of a turbo molecular pump and a power supply is switched on, it passes predetermined current in the abnormal-temperature detection sensor 15, and the model distinction circuit 31 detects the voltage signal corresponding to resistance, presumes the resistance of a sensor from this voltage signal, and distinguishes Model A. The model distinction circuit 31 stores the relation between a model and resistance in storage means, such as RAM, and can consider it as the composition which outputs the model corresponding to resistance as a model distinction signal. For example, when the detected resistance is within the limits which is 10kohm-15kohm, it judges with the connected main part of a turbo molecular pump being Model A, a model distinction signal is sent to the magnetic bearing control-parameter setting circuit 26 and the revolving-speed-control constant setting circuit 28, and the selection and a setup of each control parameter corresponding to Model A are performed. Moreover, when the detected resistance is within the limits which is 20kohm-25kohm, it judges with the connected main part of a turbo molecular pump being Model B, a model distinction signal is sent to the magnetic bearing control-parameter setting circuit 26 and the revolving-speed-control constant setting circuit 28, and the selection and a setup of each control parameter corresponding to Model B are performed. In addition, in order to change resistance for every model, it can also consider as the composition which connects resistance of predetermined resistance to the common abnormal-temperature detection sensor 15.

[0021] After setting up a control parameter, the temperature conversion circuit 32 changes the detecting signal of the abnormal-temperature detection sensor 15 into temperature, and when the abnormal temperature which detection temperature set up is exceeded, an interlock 33 controls the 2nd control computing element 27, stops operation of a motor 14, and performs operation which decreases the abnormalities in temperature of a motor successively. Drawing 2 (b) is drawing for explaining abnormal-temperature control. If the allowable-temperature range of a turbo molecular pump is made into a-b, a normal temperature region is made into a-c and the hyperthermia region used as abnormal temperature is made into c-b, the temperature conversion circuit 32 changes the signal from the abnormal-temperature detection sensor 15 into temperature, and when this temperature supervises and hyperthermia region c-b is reached, an interlock 33 will send a control signal to the 2nd control computing element 27, and will stop operation of a motor 14. The temperature rise of a motor 14 is stopped by this.

[0022] Next, the 2nd operation form of this invention is explained using the outline block diagram of drawing 3. The 2nd operation form detects a peculiar electrical property for every model of temperature sensor with which heater control is equipped, and distinguishes the model of main part of a turbo molecular pump. In drawing 3, the 2nd operation form is the almost same composition as the 1st operation form, equips the main part 1 side of a turbo molecular pump with the magnetic bearing control system 3 and the revolving-speed-control system 4, and equips a power unit 2 side with the magnetic bearing pump with the heater 17 for preventing adhesion of the resultant to the gas path in a pump etc., and the temperature sensor 16 for this heater control, and is equipped with the temperature conversion circuit 35 which asks a power unit 2 side for temperature based on the detecting signal detected by the temperature sensor 16, and the heater controller 36 which controls a heater 17 based on this temperature. In addition, let the installation part of a temperature sensor 16 be the base section of the main part of a turbo molecular pump near the gas path. Since the base section is usually formed for thermally conductive good materials, such as aluminum, it can perform temperature detection almost equivalent to a gas path portion.

[0023] With the 2nd operation gestalt, model distinction of the main part 1 of a turbo molecular pump is performed by detecting electrical properties, such as resistance with which this temperature sensor 16 is equipped peculiar for every model. Therefore, a power unit 2 is equipped with the model distinction circuit 34 linked to a temperature sensor 16. The model distinction circuit 34 can be considered as composition equivalent to the model distinction circuit 31 shown with the 1st operation gestalt, and chooses the control parameter corresponding to the model by sending a model distinction signal to the revolving-speed-control constant setting circuit 28 and the magnetic bearing control-parameter setting circuit 26.

[0024] Setting operation of the control parameter by the 2nd operation gestalt It can carry out like the 1st operation gestalt. the model distinction circuit 34 When a power unit 2 is connected to the main part 1 of a turbo molecular pump and a power supply is switched on, Pass predetermined current to a temperature sensor 16, and the voltage signal corresponding to

resistance is detected. The resistance of a sensor is presumed from this voltage signal, model distinction of the main part of a turbo molecular pump is performed, a model distinction signal is sent to the magnetic bearing control-parameter setting circuit 26 and the revolving-speed-control constant setting circuit 28, and the selection and a setup of each control parameter corresponding to the model are performed. Drawing 2 (c) is drawing for explaining a temperature control. The allowable-temperature range of a turbo molecular pump is made into a-b, and setting temperature of heater control is set to e. A heater is made into an ON state to temperature d ( $< e$ ), performs ON/OFF control in temperature requirement d-e, and controls above temperature e to be in an OFF state. By this, the temperature control of the turbo molecular pump is carried out to predetermined temperature, and adhesion of a resultant is prevented.

[0025] Next, the 3rd operation gestalt of this invention is explained using the outline block diagram of drawing 4. The 3rd operation gestalt detects a peculiar electrical property for every motor of a turbo molecular pump, or model of electromagnet, and distinguishes the model of main part of a turbo molecular pump. In drawing 4, since the 3rd operation gestalt is the almost same composition as the operation gestalt of the 1st and 2, it explains only a different portion.

[0026] With the 3rd operation gestalt, model distinction of the main part 1 of a turbo molecular pump is performed by detecting electrical properties, such as resistance with which the motor 14 or electromagnet 12 of the main part 1 of a turbo molecular pump is equipped peculiar for every model, or an inductance. Therefore, a power unit 2 is equipped with the model distinction circuit 37 linked to a motor 14 or an electromagnet 12. The model distinction circuit 37 can be considered as composition equivalent to the model distinction circuits 31 and 34 shown with the operation gestalt of the 1st and 2, and chooses the control parameter corresponding to the model by sending a model distinction signal to the revolving-speed-control constant setting circuit 28 and the magnetic bearing control-parameter setting circuit 26.

[0027] Setting operation of the control parameter by the 3rd operation gestalt It can carry out like the operation gestalt of the 1st and 2. the model distinction circuit 37 When a power unit 2 is connected to the main part 1 of a turbo molecular pump and a power supply is switched on, Pass predetermined current on a motor 14 or an electromagnet 12, and the voltage signal corresponding to resistance or the inductance is detected. The resistance or inductance of a sensor is presumed from this voltage signal, model distinction of the main part of a turbo molecular pump is performed, a model distinction signal is sent to the magnetic bearing control-parameter setting circuit 26 and the revolving-speed-control constant setting circuit 28, and the selection and a setup of each control parameter corresponding to the model are performed.

[0028] In addition, it can also consider as the composition which can also consider as the composition which installs a temperature sensor 16 in the 1st embodiment, and can also consider as the composition which installs the abnormal-temperature detection sensor 15 in the 2nd embodiment, and installs a temperature sensor 16 and the abnormal-temperature detection sensor 15 in the 3rd embodiment.

[0029] According to the embodiment of this invention, the same power unit can be applied to the main part of a turbo molecular pump of two or more kinds, and successive diminution of the kind of power unit can be aimed at.

[0030] Moreover, since the electric composition sections, such as an abnormal-temperature detection sensor with which the main part of a turbo molecular pump is equipped, a temperature sensor, a motor, and an electromagnet, can be used also distinction / model / of a pump ] according to the embodiment of this invention, wiring within a pump and connection between a pump and a power unit can be simplified.

[0031]

[Effect of the Invention] As explained above, according to this invention, the number of kinds of a power unit can be decreased to two or more kinds of main parts of a turbo molecular pump.

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[Translation done.]